A STUDY OF QUATERNARY LANDFORMS AND MATERIALS

in the

MIDWEST AND GREAT PLAINS 1/
(SR 238)

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Type I Progress Report

ERTS-1

A. A study of Quaternary Landforms and materials in the Midwest and Great Plains.

ERTS-A Proposal No. SR 238

B. GSFC ID No. of Principal Investigator: IN 404

C. Several problems have been encountered during the reporting period. Two of these have been essentially resolved. First, the original RBV data, when compared with the MSS images of the same area, reveal what can only be described as some system aberration. A comparison of the RBV red band image, 1003-16334-2, versus the MSS red band image, 1003-16334-5, reveals areas of anomalously greater density on the positive transparency of the RBV. This appears on all the RBV images, but does not appear on the MSS imagery at all. There is no obvious reason for this effect, and thus we have termed it simply a system's aberration. The MSS imagery also reveals greater contrast and definition than the RBV images (referred to above). The sum of these differences is essentially successful interpretation of the MSS images versus obscure and poorly-defined inferences from the RBV images.

The second problem, which has been resolved, was the "reversed skew" of the MSS images. This actually produced some features of interest (see section D) which might not have been apparent otherwise.

Several other problems are still impeding investigations. Two problems involve processing procedures. The negatives which have been received to date are much too dense to be very useful. High quality prints cannot be produced from these negatives with normal darkroom equipment, because of the exceptionally long exposures required. A second processing error is superimposing circular features on the positive transparencies. These features appear to be Newton-rings, which can be imposed on transparencies (negative or positive) if an uncorrected glass plate or negative holder is used in the processing. These features are well expressed on image 1027-17070-4 through 7. These rings obscure detail on what is generally a good image.

The investigations have attempted to compose the MSS images on an I^{2}s mini-addicol viewer (Model 6040). In general (information based on the registration of six images), bands 4, 5, and 6 can be registered, but band 7 is usually too large. On one image (1027-17070) change in scale affected bands 4 and 7.

The investigation has also been hampered because of the time of year of image aquisition. Extensive crop cover and natural foliage in the Midwest obscures any signal which may be unique to different surficial materials, and this has hampered many aspects of interpretation. We have also found that atmospheric conditions in the humid Midwest during this time of year are obscuring imagery with even as little as 5 to 10% cloud cover. These conditions will improve as imagery is acquired during the winter and spring.

D. The initial evaluation of ERTS imagery during this report period must be reported in two parts -- general interpretation information and actual image interpretation. The 70mm negatives were not usable, as discussed above, thus, for interpretations, prints were made from the positive transparencies. These negative prints were produced at 1:1,000,000 scale and at larger scales where necessary.

General Interpretation Information.

Practical Resolution-Detection Measurements:

Measurements were made on prints made from positive transparencies to determine practical working estimates of detectability in the Midwest imagery. Four high-quality images were used for this procedure:

1003-16334-5
1-37-16210-5
1037-16213-5 and 7

Prints at scales of 1:5,000,000, 1:375,000. and 1:250,000 were used. The smallest detectable and measurable objects were qualitatively of moderate to high contrast and scale measurements indicated they were roughly 150 feet in diameter. Diameter is used because the objects are not identifiable as anything but a detectable point on the smaller scale prints used. The smallest features which can be identified as part of a recognizable agricultural pattern are approximately 300 feet on a side for high-contrast and 400 to 500 feet for moderate-contrast features. Rural gravel roads are clearly displayed on the red-band images due to their linearity and high-contrast and response in this spectral region. These road right-of-ways, which include roadbed, shoulder, ditches, and backslope, range from about 65 feet to 120 feet with the standard width of 74-80 feet. Several of these were measured on the negative prints, indicating widths of 200 feet or more -- due to the "spread" effect associated with bright (highly-reflective) objects, and the instantaneous field of view of the system.On the infra-red image (MSS-7) a known farm pond slightly over 1 acre in area (100 X 500 feet) was detectable on a 1:500,000 scale print.

Color Additive Viewing:

As noted earlier, attempts at color additive viewing have been generally successful. One early RBV image (1005-16454) could not be registered. In later attempts on six MSS images it was found on five images that bands 4 through 6 could be registered for color additive viewing. Band 7 in all six cases was at a slightly smaller scale (larger image). On the sixth image band 4 was also a smaller scale -- but not as small as band 7.

Image Interpretation.

In general, band 5 is the most useful band in the Midwest-Great Plains region. The infrared bands have very little usefulness this time of year, because of the crop cover and foliage. Interpretation of landforms and glacial features is also obscured by the vegetation in most of the imagery received so far. Interpretations to date must be based on land-use patterns as affected by topography. Differences in soils and surficial materials, which will allow a more detailed analysis, will only be possible in spring and possibly winter. This, of course, is the value of the repeated coverage of ERTS-1, and present interpretations must be preliminary.

1003-16334

Several interesting features appear on the MSS version of this image. A comparison of the RBV and MSS imagery was discussed in section C.

1. A poorly expressed circular "feature" appears in the west-central portion of the image. It is most apparent on MSS 2 and the MSS color composite. This circular feature is apparent because of an anomalous drainage pattern in the region. The trees following the stream valleys emphasize the outline of the area. The asymmetry of the drainage produced the "feature;" notably the asymmetry of tributaries to the northeast in the East Nishnabotna basin, and the bulge in this basin toward its head. Comparison of this area with bedrock topographic maps suggests that these features reveal influences of the bedrock topography. Despite a relatively thick cover of glacial materials (150 to 200 feet), it appears that the asymmetry of the drainage is a product of regional slopes inherited from the bedrock topographic surface. Many of the surficial streams parallel sags or channels in the bedrock surface.

One interesting note is that the circularity is produced by the uncorrected skew in the MSS imagery. This early MSS image has been skewed incorrectly, and this elongated the NW-SE axis of this area to produce the circular appearance.

2. In the NE portion of this image the Des Moines glacial lobe of Wisconsinan age (14-13,000 years b.p.) is readily distinguishable from the older drift region of southern Iowa. South of the mapped boundary of the Des Moines lobe, in the North and Middle River basins, there is an area, in terms of photo-interpretation (tone-texture, etc.), which appears much more like the Des Moines lobe than it does like the older dissected drift topography of southern Iowa. Several things are

apparent in this area; the glacial deposits are extremely thin in this area (averaging 50 feet over much of the area); It is underlain by resistant Pennsylvanian limestone; the present streams are incised into the bedrock, at right angles to the strike of the bedrock units. Tentatively, it seems that this anomaly is also a reflection of the bedrock topography in the present landscape, the degree of dissection being controlled by the very thin drift over the resistant limestone bedrock. Other alternatives must be considered. The streams involved parallel the arcuate terminus of the Des Moines lobe, which suggests some relationship to the glacial events. This possibility remains open, and will be checked by field investigations.

3. The infrared bands reveal another interesting feature. A series of arcuate bands run from NW to SE in the western portion of the image. They are poor reflectors of IR, and appear dark-toned on the positive transparencies. They appear on both RBV and MSS imagery. No explanation can be offered at present. Repetitive coverage may be helpful in analyzing these features.

1037-16210, 16213, 16215

These three images cover the eastern third of Iowa and parts of adjacent states. The various glacial-physiographic areas are clearly evident. Their various boundaries, and some minor features, are, in places, obscure. Again, the time of year of the imagery is very poor for mapping unconsolidated materials.

Scale prints of these images have been compared with base maps of Iowa at 1:1,000,000, 1:500,000, and 1:250,000. Even without precision processing they appear to meet the accuracy of present maps. The images can easily update and improve the accuracy of cultural features on these maps. Preliminary results indicate that level 1 land-use classification, as outlined by Anderson, et.al.(1972, U.S. Geological Survey Circular 671), can readily be applied to the ERTS imagery. A more detailed test of this is planned for the next report period.

Image 16213 has been compared with 1969 A.S.C.S. photo-mosaics of Scott County, Iowa, at a scale of 1 inch to the mile. This imagery was flown in late spring and certain features are much more apparent than on the late-summer ERTS imagery. The Cleona Channel, a glacial diversion channel of the Mississippi River, is only evident on the ERTS imagery where it influences major streams such as the Cedar and Wapsipinicon Rivers. The broad sag between these areas shows on the spring mosaic because of

different soil and soil-moisture properties, which cannot be seen on the summer ERTS imagery. Also, Paha lineations which show up very strongly on the mosaic do not show up on the ERTS imagery at all. Again, these features have evident soil differences, but do not topographically obscure agricultural patterns enough to be recognizable.

On Image 16210, preliminary attempts at additive color viewing appear to reveal trends of color differences which may relate to topographic-geologic boundaries of bedrock units in northeastern Iowa.

1027-17070

This image encompasses parts of northwestern Nebraska and southwestern South Dakota. In the climatic regime of this area crops and natural vegetation do not obscure geologic information to the same degree as in the Midwest. Preliminary analysis at 1:1,000,000 has allowed descrimination of several basic dune series in the Sand Hills region, as described by Smith (1965, Journal of Geology, p. 557-578). The boundary of the Oligocene, White River Group, and the Miocene Arikaree Formation, is clearly mappable along the Pine Ridge escarpment. Preliminary attempts at color-additive viewing, and density-slicing enhancement appear to make more detailed mapping possible. During the next report period more detailed soils-geologic mapping will be attempted from imagery in this area.

1034-16052

This image shows the confluence of the Mississippi and Ohio Rivers. Many large-scale floodplain features, such as meander scars, oxbow lakes, and cutoff channels, are evident in these major valleys. The Cache Valley, a Wisconsinan age glacial spillway of the Ohio River, can be delineated also. Scattered cloud cover obscures many details in the area.

Many of the other images received have been of rather poor quality, generally due to cloud cover and atmospheric conditions.

During the next report period more detailed analysis will continue, as outlined above. Preliminary evaluation of new imagery will continue, and, we hope, comparison of repetitive coverage can begin.

E. Measurements made from prints of ERTS-1, MSS 5 images, show practical limits of detectability for this imagery in the Midwest. The smallest high contrast object detectable has an approximate measured diameter of 150 feet. The smallest clearly identifiable cultural feature is roughly 300 feet for high contrast, and 400 to 500 feet for low contrast objects. Rural roadways, with an average actual width of 75 feet, are clearly defined on the imagery, due to high-reflectivity, linearity, and the instantaneous field of view of the scanner. On the infrared a farm pond slightly greater than one acre is detectable.

Crop and natural foliage cover in the Midwest during summer months obscures geologic and soils information on the imagery, and hinders detailed mapping of these phenomena. In the western Great Plains (northwestern Nebraska) large-scale mapping of this kind may be possible, even at this time of year.

In southwestern Iowa, topographic and drainage system anomalies, revealed by the imagery, are related to the slope of and depth to the buried bedrock surface. In eastern Iowa, level 1, land-use classification can be done from ERTS imagery. The accuracy of this classification will be tested.

Category: 2A; 3I; 8G.

F. N.A.

G. The processing procedure problems described in section C need serious attention. The overexposure of the negatives being sent to investigators must be corrected. This would seem to be an easy matter, but perhaps not.

If the "rings" described in section C are indeed Newton rings, imposed by a glass plate, these plates should be replaced with anti-Newton ring glass such as that used in glass-slide mounts.

H. N.A.

I. Image Descriptor Forms.

J. N.A.

K. N.A.

ERTS IMAGE DESCRIPTOR FORM

 (See Instructions on Back)

NDPF USE ONLY
D _____
N _____
ID _____

DATE 25 October 1972

PRINCIPAL INVESTIGATOR 1. Roger B. Morrison
2. George R. Hallberg

GSFC IN 404

ORGANIZATION 1. U.S. Geological Survey
2. Iowa Geological Survey

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Cropland	Floodplain	City	
1003-16334-2,5	x	x	x	EED Cropland EED Agriculture Parallel Drainage Rural Area Scattered Clouds
1003-16341-2	x	x		Clouds Parallel Drainage
1003-16343-2	x			Clouds
1003-16350-2	x	x		Lake Dendritic Drainage Meander Scattered Clouds
1005-16454-2				Clouds
1026-17024-5	x	x		Scattered Clouds
1027-17070-2 -7	x	x		EEO Dunes Lakes Ridge
1034-16052-5	x	x		Lake Meander Scattered Clouds
1036-16162-5		x	x	Urban Area Meander Vegetation

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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GSFC 37-2 (7/72)

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PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS* Cropland	Floodplain	City	DESCRIPTORS
1037-16210-5	x	x		City Entrenched Stream Rural Area Vegetation
-6,7	x			EED Braided Stream
1037-16213-5,6,7	x	x	x	Lake Meander Quarry Sediment Shallow Water
1037-16215-5	x	x		

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